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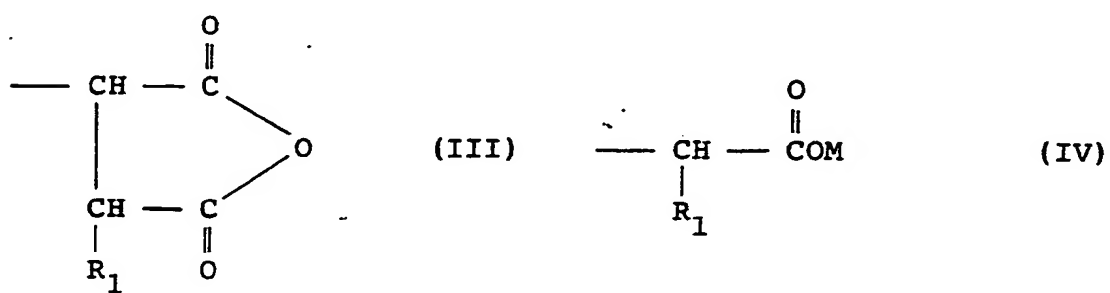
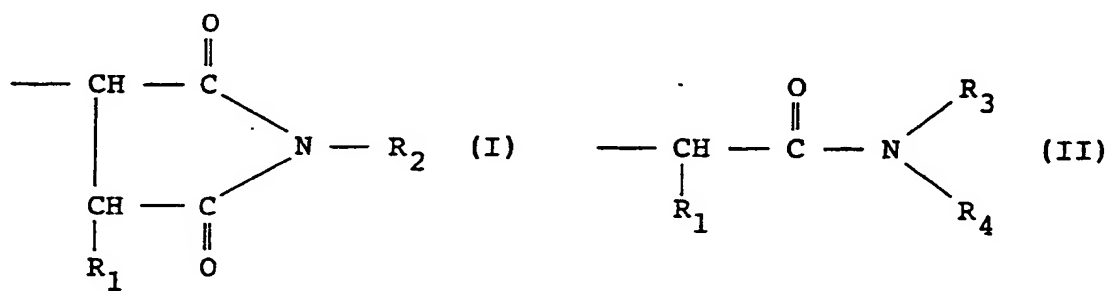
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(54) **Resin compositions and their manufacturing method.**

(57) Resin compositions consisting of (A) 50 - 95 percent by weight of a polyamide and (B) 5 - 50 percent by weight of a modified polyolefin containing in side chains 0.005 - 5 molar percent of functional groups expressed by formulas (I) and/or (II) below and 0.005 - 5 molar percent of functional groups expressed by formulas (III) and/or (IV) below provide molds having a high impact resistance and are applicable to automobile parts.

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## Resin Compositions and Their Manufacturing Method

### Background of the Invention

#### Field of the Invention

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This invention relates to polyamide resin compositions distinguished in impact resistance, moldability and manufacturing stability and their manufacturing method.

#### 10 Description of the Prior Art

Recently, for the purpose of improving the impact resistance of polyamides, resin compositions having various polyolefins incorporated have been investigated. In order for the impact resistance to be improved, it is required that the polyamide and polyolefin present a tightly combined state, and for such purpose, 15 technologies of modifying polyolefin have been proposed. As a typical example of the polyamide and modified polyolefin compositions and their manufacturing methods heretofore known, a method of preparing a modified polyolefin having carboxyl or acid anhydride groups and melt compounding it with a polyamide as described in U.S. Pat. No. 4,174,358 or a method of preparing a modified polyolefin having imide or amide groups and melt compounding it with a polyamide as described in U.S. Pat. No. 4,612,346, may be cited. 20

However, it was known that the resin compositions shown in U.S. Pat. No. 4,174,358 had difficulties in the flow at the time of injection molding and surface appearance of the molded articles. The resin compositions shown in U.S. Pat. No. 4,612,346 were found to have a problem that they were of poor stability in manufacturing, that is, the gut emitted from the extruder was of poor spinnability, resulting in 25 frequent cutting of the gut. Also, in these prior arts, a method of preparing a modified polyolefin having various functional groups and melt compounding it with a polyamide is disclosed, and it is noted as one of the requisites that as the polyamide and modified polyolefin have to be finely admixed with each other, the modified polyolefin should not be cross-linked substantially.

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#### Brief Summary of the Invention

An object of the present invention is to provide resin compositions comprised of a polyamide and a polyolefin and distinguished in impact resistance, flow in injection molding and stability in manufacturing.

35 Another object of the present invention is to provide a novel and efficient manufacturing method of resin compositions consisting of a polyamide and a polyolefin.

Still another object of the present invention is to provide resin compositions having a specially designated modified polyolefin incorporated for the polyamide in order to satisfy all of the requirements for impact resistance, molding flow and manufacturing stability.

40 A further object of the present invention is to provide resin compositions having incorporated to a polyamide and a polyolefin having specific kinds and quantities of functional groups in the side chains.

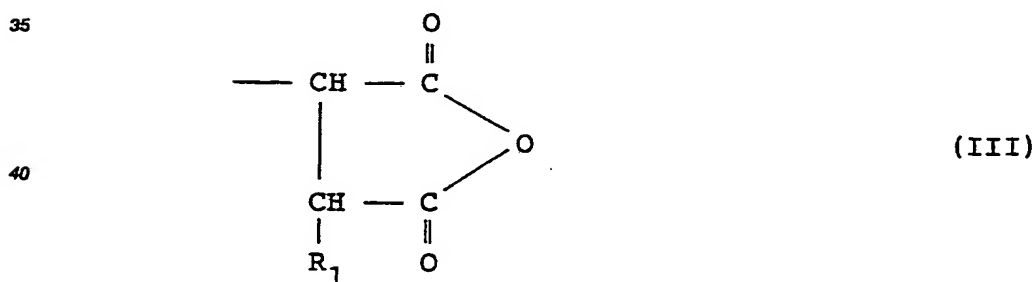
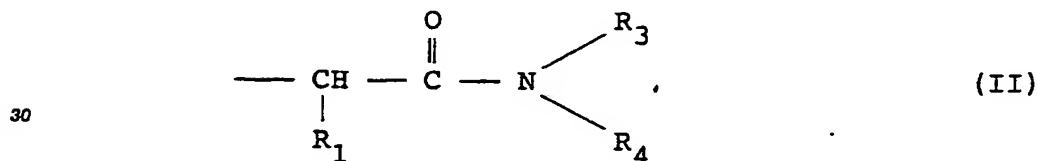
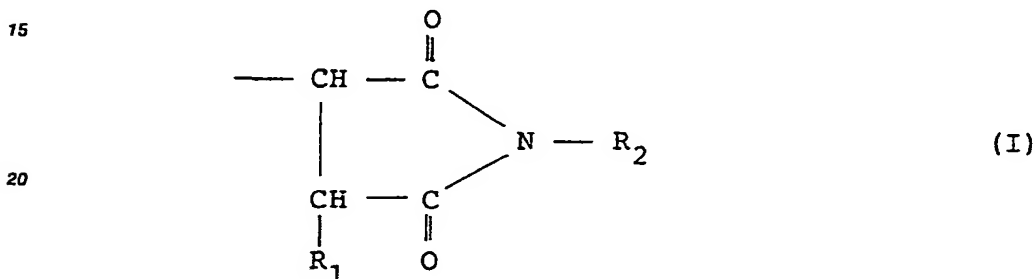
A still further object of the present invention is to provide resin compositions having incorporated to a polyamide and a modified polyolefin having both functional groups of imide and/or amide groups expressed by formulas (I) and/or (II) described later and acid anhydride and/or carboxyl groups expressed by formulas 45 (III) and/or (IV) also described later.

A still further object of the present invention is to provide a method of stably manufacturing resin compositions distinguished in impact resistance and molding flow by melt compounding of a polyamide and a polyolefin, in the presence of an  $\alpha,\beta$ -unsaturated imide compound and/or an  $\alpha,\beta$ -unsaturated amide compound and an  $\alpha,\beta$ -unsaturated carboxylic acid compound and/or an  $\alpha,\beta$ -unsaturated carboxylic acid anhydride and an organic peroxide. 50

A still further object of the present invention is to provide a manufacturing method of resin compounds in which modification of polyolefin and compounding of polyolefin and polyamide are carried out simultaneously using at least two kinds of compounds as a modifier of polyolefin.

A still further object of the present invention is to provide resin compositions and manufacturing method thereof having a modified polyolefin partially cross-linked and dispersed in a polyamide or, more particularly, having the modification and cross-linking of the polyolefin proceeded concurrently during the process of compounding so that the polyolefin is finely dispersed in the polyamide to form a fine morphology.

To achieve the objects of the present invention, the resin compositions of the invention are comprised of (A) 50 - 95 percent by weight, preferably 55 - 93 percent by weight or more preferably 60-90 percent by weight of a polyamide and (B) 5 - 50 percent by weight, preferably 7 - 45 percent by weight or more preferably 10 - 40 percent by weight of a modified polyolefin containing in the side chains 0.005 - 5 mol percent, preferably 0.01 - 4.5 mol percent or more preferably 0.02 - 4 mol percent of a functional group or groups expressed by the following formulas (I) and/or (II) and 0.005 - 5 mol percent, preferably 0.008 - 4 mol percent or more preferably 0.01 - 3 mol percent of a functional group or groups expressed by the formulas (III) and/or (IV).



Here, R<sub>1</sub> represents a hydrogen atom or methyl group, and R<sub>2</sub>, R<sub>3</sub> and R<sub>4</sub> represent respectively a hydrogen atom or aliphatic, alicyclic or aromatic residue having 1 - 30 carbon atoms, preferably R<sub>2</sub> being a functional group chosen from alkyl having 1 - 10 carbon atoms, phenyl, cyclohexyl and benzyl groups and R<sub>3</sub> and R<sub>4</sub> being respectively a hydrogen atom or an alkyl group having 1 - 10 carbon atoms, and M represents a hydrogen atom or a metallic ion of a valence of 1 - 3.

Description of the Preferred Embodiments

Polyamides used in the present invention are polymers having an amide bond, and the components may be chosen from amino acids such as 6-aminocaproic acid, 11-aminoundecanoic acid, 12-aminododecanoic acid, para-aminomethylbenzoic acid, lactams such as  $\epsilon$ -caprolactam and  $\omega$ -laurolactam, diamines such as tetramethylenediamine, hexamethylenediamine, undecamethylenediamine, dodecamethylenediamine, 2,2,4-/2,4,4-trimethylhexamethylenediamine, 5-methylnonamethylenediamine, metaxylylenediamine, paraxylylenediamine, 1,3-bis(aminomethyl)cyclohexane, 1,4-bis(aminomethyl)cyclohexane, 1-amino-3-aminomethyl-3,5,5-trimethylcyclohexane, bis(4-aminocyclohexyl)methane, bis(3-methyl-4-aminocyclohexyl)methane, 2,2-bis(aminocyclohexyl)propane, bis(aminopropyl)piperazine and aminoethyl piperazine, and dicarboxylic acids such as adipic acid, suberic acid, azelaic acid, dodecanedioic acid, terephthalic acid, isophthalic acid, 2-chloroterephthalic acid, 2-methylterephthalic acid, 5-methylisophthalic acid, 5-sodium-sulfoisophthalic acid, hexahydroterephthalic acid, hexahydroisophthalic acid and diglycolic acid. Particularly, the useful polyamides according to the present invention are polycaproamide (nylon 6), polyhexamethyleneadipamide (nylon 66), polyhexamethylenesecbacamide (nylon 610), polyhexamethylenedodecamide (nylon 612), polyundecanamide (nylon 11), polydodecanamide (nylon 12), polytrimethylhexamethyleneterephthalamide (nylon TMDT), polyhexamethyleneisophthalamide (nylon 6I), polyhexamethyleneterephthalamide (nylon 6T), polybis(4-aminocyclohexyl)methanedodecamide (nylon PACM 12), polymetaxyleneadipamide (nylon MXD 6), polyundecamethyleneterephthalamide (nylon 11T), polydedecamethyleneterephthalamide (nylon 12T), and their copolymers and mixtures.

The polyamides used here have no restriction in the degree of polymerization, and those of a relative viscosity within the range of 1.5 - 5.0 can be chosen, as desired. For the manufacturing method of polyamide, there is no restriction, and the polyamides can be prepared by any well-known method such as melt polymerization or solid phase polymerization.

The polyolefin used according to the present invention is a polymer which has as a main component an  $\alpha$ -olefin or diene of a carbon atom number of 2 - 20 such as, for example, ethylene, propylene, butene-1, pentene-1, 4-methylpentene-1, isobutylene, 1,4-hexadiene, dicyclopentadiene, 2,5-norbornadiene, 5-ethyl-2,5-norbornadiene, 5-ethylidenenorbornene, 5-(1'-propenyl)-2-norbornene, butadiene, isoprene and chloroprene.

As a specific example of polyolefin particularly useful according to the present invention, there may be cited polyethylene, polypropylene, polybutene, poly(4-methylpentene-1), poly(ethylene/propylene), poly(ethylene/butene-1), poly(ethylene/propylene/1,4-hexadiene), poly(ethylene/propylene/dicyclopentadiene), poly(ethylene/propylene/2,5-norbornadiene) or poly(ethylene/propylene/5-ethylidenenorbornene). For the degree of polymerization of the polyolefin, there is no restriction particularly, and a polyolefin of a melt index within the range of 0.05 - 50 g/10 min can be chosen, as desired. Also, for the manufacturing method of polyolefin, there is no restriction, and a well-known method such as high pressure radical polymerization, low pressure catalytic method or solution polymerization is usable.

The  $\alpha,\beta$ -unsaturated imide and  $\alpha,\beta$ -unsaturated amide compounds used according to the present invention include, for example, maleimide, N-methylmaleimide, N-ethylmaleimide, N-propylmaleimide, N-butylmaleimide, N-octylmaleimide, N-phenylmaleimide, N-(o-methylphenyl)maleimide, N-(m-methylphenyl)maleimide, N-(p-methylphenyl)maleimide, N-(methoxyphenyl)maleimide, N-(chlorophenyl)maleimide, N-(carboxyphenyl)maleimide, N-benzylmaleimide, N-naphthylmaleimide, N-cyclohexylmaleimide, itaconimide, N-methylitaconimide, N-phenylitaconimide, acrylamide, N-methylacrylamide, N-ethylacrylamide, N-propylacrylamide, N-butylacrylamide, N-octylacrylamide, N-stearylacrylamide, N-methylolacrylamide, N-hydroxymethylacrylamide, N-cyanoethylacrylamide, N-phenylacrylamide, N-tolylacrylamide, N,N-dimethylacrylamide, N,N-diethylacrylamide, N-methyl-N-ethylacrylamide, diacetoneacrylamide, methacrylamide, N-methylmethacrylamide, N-ethylmethacrylamide, N-propylmethacrylamide, N-butylmethacrylamide, N-stearylmethacrylamide, N-methylolmethacrylamide, N-hydroxymethylmethacrylamide, N-cyanoethylmethacrylamide, N-phenylmethacrylamide, N-benzylmethacrylamide, N,N-dimethylmethacrylamide and N,N-diethylmethacrylamide.

Unsaturated imide compounds and unsaturated amide compounds preferably usable according to the present invention are those melting at 180°C or lower and boiling at 200°C or higher under atmospheric pressure, and particularly, N-cyclohexylmaleimide, N-benzylmaleimide, N-phenylmaleimide, N-(carboxyphenyl)maleimide, acrylamide and methacrylamide are adequate compounds.

The  $\alpha,\beta$ -unsaturated carboxylic acids and  $\alpha,\beta$ -unsaturated carboxylic acid anhydrides usable according to the present invention include, for example, acrylic acid, methacrylic acid, maleic acid, itaconic acid, crotonic acid, methylmaleic acid, methylfumaric acid, mesaconic acid, citraconic acid, glutaconic acid, methyl hydrogen maleate, ethyl hydrogen maleate, butyl hydrogen maleate, methyl hydrogen itaconate,

ethyl hydrogen itaconate, maleic anhydride, itaconic anhydride and citraconic anhydride. Among the unsaturated carboxylic acid derivatives, those melting at 180°C or lower and boiling at 200°C or higher under atmospheric pressure are preferably usable, and particularly suitable compounds are acrylic acid, methacrylic acid, maleic acid, fumaric acid, methyl hydrogen maleate, maleic anhydride and itaconic anhydride.

It is one of the features of the method of the present invention to use both of (c)  $\alpha,\beta$ -unsaturated imide or  $\alpha,\beta$ -unsaturated amide compounds and (d)  $\alpha,\beta$ -unsaturated carboxylic compound or  $\alpha,\beta$ -unsaturated carboxylic acid anhydride. Unsaturated imide and unsaturated amide compounds are effective for improving the compatibility of polyolefin to polyamide and have further a function not to degrade the molding fluidity. The unsaturated carboxylic acid derivative participates in the reaction of polyolefin with polyamide, and when the polyolefin is not well fixed in the polyamide matrix, the melt compounded gut is of poor spinnability, resulting in decrease of manufacturing efficiency. When the unsaturated carboxylic acid derivative is added in an excessive amount, the polyolefin reacts with the polyamide while it undergoes cross-linking, and so the flow of the whole compound is extremely deteriorated. Thus, the  $\alpha,\beta$ -unsaturated imide compound and the  $\alpha,\beta$ -unsaturated carboxylic acid compound or its anhydride play a different role respectively, and only when both are present, a valuable product is provided.

The organic peroxides used according to the present invention include, for example, cumene hydroperoxide, t-butyl cumyl peroxide, di-t-butyl peroxide, 2,5-dimethyl-2,5-di(t-butylperoxy)hexane, 2,5-dimethyl-2,5-di(t-butylperoxy)hexyne-(3), 2,5-dimethylhexane-2,5-dihydroperoxide, t-butyl hydroperoxide, diisopropylbenzene hydroperoxide, p-methane hydroperoxide, 1,1-bis-t-butylperoxy-3,3,5-trimethylcyclohexane, n-butyl-4,4-bis-t-butylperoxy valerate and t-butylperoxy benzoate. According to the method of the invention, the peroxide should decompose quickly at the melt compounding temperature, and organic peroxides of which the decomposition temperature showing a half-life of 1 minute is within the range of 150 - 250°C are preferably used.

According to the invention, to 100 parts by weight of a mixture of (a) 50 - 95% by weight, preferably 55 - 93% by weight or more preferably 60 - 90% by weight of a polyamide and (b) 5 - 50% by weight, preferably 7-45% by weight or more preferably 10 - 40% by weight of a polyolefin are added (c) 0.02 - 5 parts by weight, preferably 0.05 - 3 parts by weight or more preferably 0.07-1 part by weight of an  $\alpha,\beta$ -unsaturated imide compound and/or  $\alpha,\beta$ -unsaturated amide compound, (d) 0.01 - 3 parts by weight, preferably 0.02 - 1 part by weight or more preferably 0.02 - 1 part by weight of an  $\alpha,\beta$ -unsaturated carboxylic acid compound and/or  $\alpha,\beta$ -unsaturated carboxylic acid anhydride and (e) 0.001 - 0.8 part by weight, preferably 0.04 - 0.5 part by weight or more preferably 0.008 - 0.2 part by weight of an organic peroxide, and the mixture is melt compounded.

Deviation of the proportion of mixture of the polyamide and polyolefin from the foregoing limiting range is not desirable in that the intended balance of mechanical properties such as impact resistance and rigidity is not achieved.

Lower amounts of addition of the modifiers, that is,  $\alpha,\beta$ -unsaturated imide compound,  $\alpha,\beta$ -unsaturated amide compound and  $\alpha,\beta$ -unsaturated carboxylic acid derivative than the lower limit values specified as above are not desirable in that the compatibility of polyamide and polyolefin is deteriorated and that the impact resistance and other mechanical properties are degraded. On the other hand, if the amounts of the modifiers exceed the foregoing upper limit values, all of the modifiers are not consumed for modification of the polyolefin, and the remaining modifiers bleed out on the surface of the mold to impair the appearance or cause undesirable phenomena such as deterioration of the stability of polyolefin.

According to the present invention, the polyamide and polyolefin in the form of pellets, powder or chips are usually premixed with the  $\alpha,\beta$ -unsaturated imide compound,  $\alpha,\beta$ -unsaturated carboxylic acid compound or its anhydride and organic peroxide, and then is fed to a single or multiple screw extruder having a sufficient compounding capacity for melt compounding.

According to the method of the invention, the polyolefin is partially cross-linked during the process of compounding. The extent of cross-linking can be determined by the solubility to a solvent. From the following experiment, it was found that before melt compounding with a polyamide, a poly(ethylene/propylene) copolymer completely soluble in a solvent such as toluene, when dispersed in the polyamide matrix according to the method of the invention, would have a cross-linked structure having an insoluble part in the solvent. That is, the poly(ethylene/propylene) copolymer remaining after hydrolysis of the polyamide with hydrochloric acid did not completely dissolve in toluene and had a cross-linked insoluble part present. According to the method of the invention, it has become possible to finely disperse a partially cross-linked modified polyolefin in a polyamide matrix which has not been conceivable by the common knowledge heretofore maintained. As the rubber component is cross-linked, the impact resistance and rigidity are further improved, and a material of a very high practical value is obtainable.

The resin compositions of the present invention may have any other component or components such as pigment, dye, reinforcing agent, filler, heat stabilizer, antioxidant, weather stabilizer, lubricant, nucleating agent, antiblocking agent, mold releasing agent, plasticizer, flame retarding agent, antistatic agent and any other polymer added thereto so long as the moldability and physical properties are not damaged.

5 The resin compositions of the invention are applicable to injection molding, extrusion molding, blow molding, compression molding and other molding processes ordinarily used for the thermoplastic resins, and when molded, they provide molds having the well balanced mechanical properties which are useful as automobile parts, mechanical parts, electric and electronic parts and general goods.

10 The present invention will now be described in detail with reference to some embodiments. Evaluation of the characteristics of the polymers and molds noted in the embodying examples and references was made according to the following methods.

- (1) Relative viscosity of polyamide: JIS K6810
- (2) Melt index: JIS K7210
- (3) Tensile properties: ASTM D638
- 15 (4) Flexural properties: ASTM D790
- (5) Izod impact strength: ASTM D256
- (6) Injection molding flow: Spiral flow length evaluated

## 20 Example 1

Through melt polymerization of  $\epsilon$ -caprolactum, nylon 6 of a relative viscosity of 3.10 was prepared. Polymerizing a mixture of 75 mol% of ethylene and 25 mol% of propylene, a poly(ethylene/propylene) copolymer was prepared. For a total 100 parts by weight of nylon 6 75% by weight and poly-  
 25 (ethylene/propylene) copolymer 25% by weight, 0.4 part by weight of N-cyclohexylmaleimide, 0.3 part by weight of maleic anhydride and 0.1 part by weight of 2,5-dimethyl-2,5-di(t-butylperoxy)hexyne-(3) were added, and the whole was premixed, then it was melted and compounded at 250°C with a 60 mm $\phi$  twin screw extruder used into pellets. Spinnability of the gut discharged out of the extruder was very stable, and gut cutting occurred scarcely during the continuous run for long hours.

30 The pellet obtained here was subjected to analysis and test according to the following method.

The pellet was treated with hydrochloric acid for hydrolysis of the nylon part, and then infrared absorption spectrum of the residue was examined. The residue had absorptions noted at 1460  $\text{cm}^{-1}$ , 1380  $\text{cm}^{-1}$  and 710  $\text{cm}^{-1}$  and was thus found to be a modified poly(ethylene/propylene) copolymer. This remaining modified poly(ethylene/propylene) copolymer did not completely dissolve in toluene and was  
 35 thus found to be partially cross-linked during the compounding process. It was confirmed that the original poly(ethylene/propylene) copolymer completely dissolve in toluene and that the partial cross-linking was not caused by the hydrochloric acid treatment.

Next, the pellet obtained here was vacuum dried and was injection molded into a test specimen, and the flow at the time of molding and the mechanical properties of the test specimen thus obtained were  
 40 tested, as shown in Table 1. As shown, it was found to be a material of high practical value.

## Reference 1

45 To 100 parts by weight of the poly(ethylene/propylene) copolymer used in Example 1, 1.6 parts by weight of N-cyclohexylmaleimide, 1.2 parts by weight of maleic anhydride and 0.4 part by weight of 2,5-dimethyl-2,5-di(t-butylperoxy)hexyne-(3) were added, and the mixture was compounded at 250°C with a 40 mm $\phi$  extruder used. The modified poly(ethylene/propylene) copolymer obtained here did not completely dissolve in toluene and was found to be cross-linked.

50 To nylon 6 used in Example 1, 25% by weight of this cross-linked modified poly(ethylene/propylene) copolymer was added, then the mixture was compounded under the same condition to that of Example 1, and the physical properties of the injection molded test specimen were evaluated. The results are shown in Table 1. It was thus found that according to the method of mixing and compounding the cross-linked polyolefin with the nylon, dispersion of the polyolefin would not be good, the impact resistance would not be  
 55 satisfactory and the surface appearance of the mold would be poor and that it would be inadequate unless the partial cross-linking and modification of polyolefin would proceed simultaneously during compounding process with nylon.

References 2 to 5

Except the amounts of N-cyclohexylmaleimide and maleic anhydride in Example 1 were changed as shown in Table 1, evaluation of the mechanical properties of the extruder compounded and injection molded test specimens was carried out. It was found that extreme depression of spinability, melt flowability or mechanical properties occurred when the amounts of modifiers deviate from the ranges specified in the invention.

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Table 1

	Example 1	Reference 1	Reference 2	Reference 3	Reference 4	Reference 5
(a) Polyamide (Relative viscosity) (Compounding) (Weight %)	N-6 (3.10) (75)	+	+	+	+	+
(b) Polyolefin (Melt index) (g/10 min) (Compounding) (Weight %)	EPR (7) (25)	+	+	+	+	+
(c) Unsaturated imide compound (Addition) (Parts by weight/ 100 Parts by weight)	NCIM (0.4)	+	+	+	+	+
(d) Unsaturated carboxylic acid or its anhydride (Addition) (Parts by weight/ 100 Parts by weight)	HLA (0.3)	+	+	+	+	+
(e) Organic peroxide (Addition) (Parts by weight/ 100 Parts by weight)	DBPH (0.1)	+	+	+	+	+
Compounding method Discharge from extruder	One-stage Stable, good	Two-stage Practicable	One-stage Poor spinnability of gut	Gut cutting frequently	Gut tending to foam	Viscosity increasing abnormally
Injection molding flow (Spiral flow length) (mm)	110	83	118	76	113	28
Tensile strength (kg/cm <sup>2</sup> )	500	450	510	500	480	500
Flexural strength (kg/cm <sup>2</sup> )	700	700	710	710	650	700
Flexural modulus (kg/cm <sup>2</sup> )	18,200	18,300	18,500	18,300	17,600	18,000
Izod impact strength (kg·cm/cm notch)	65	13	32	65	60	63
Mold surface appearance	Good	Lustrous & not good	Good	Ordinary	Bleed-out noted	Not good

(a) N-6: Nylon 6; (b) EPR: Poly(ethylene/propylene) copolymer; (c) NCIM: N-cyclohexylmaleimide; (d) HLA: Maleic anhydride;  
 (e) DBPH: 2,5-dimethyl-2,5-di(t-butylperoxy)hexane-3

Injection molding flow: Temperature, 250°C; Injection pressure, 1,000 kg/cm<sup>2</sup>; Test specimen thickness, 1.0 mm

Mechanical properties: 23°C, dry

Examples 2 to 29

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Changing the types and quantities of the polyamide, polyolefin, modifiers and peroxide and operating similarly to Example 1, the discharge stability from the extruder, injection molding flow and physical properties of the molded test specimens were tested, with the results shown in Table 2. It was found that in any case shown in Table 2, a material distinguished in extrusion workability, injection molding flow and mechanical properties would be obtainable.

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Table 2 (1)

Examples	2	3	4	5	6	7	8
(a) Polyamide (1) Type Relative viscosity Compounding (Weight %)	N-66 2.90 80	N-610 2.50 70	N-612 2.50 60	N-12 2.30 80	N-6/66/85/15 3.40 70	N-6/66/10/90 3.10 75	N-6/12/80/20 2.70 80
(b) Polyolefin (1) Type Melt index (g/10 min) Compounding (Weight %)	E/PP 7 20	PP 13 30	PMP 25 40	PE 20 20	E/PT 5 10	+	+
(c) Unsaturated imide or amide compound Addition (Parts by weight/ 100 Parts by weight)	N-phenylmaleimide 0.3	+	+	+	N-ethylmaleimide 0.25	+	N-butylmaleimide 0.4
(d) Unsaturated carboxylic acid or its anhydride Addition (Parts by weight/ 100 Parts by weight)	Maleic anhydride 0.15	+	+	+	Maleic acid 0.2	+	Maleicrylic acid 0.2
(e) Organic peroxide Addition (Parts by weight/ 100 Parts by weight)	Cumene hydroperoxide 0.07	+	+	+	+	Butylperoxy benzoate 0.05	+
Discharge from extruder Polyolefin cross-linking	Good Yes	+	+	+	+	+	+
Injection molding temperature (°C) Injection molding pressure (kg/cm <sup>2</sup> ) Injection molding spiral flow length (cm)	280 1,000 103	250 1,000 110	270 1,000 85	230 1,000 100	250 1,000 90	270 1,000 100	230 1,000 92
Tensile strength (kg/cm <sup>2</sup> ) Flexural strength (kg/cm <sup>2</sup> ) Flexural modulus (kg/cm <sup>2</sup> ) Izod impact strength (kg-cm/cm notch)	550 780 18,800 55	650 810 23,200 15	660 830 24,000 18	440 650 14,000 90	430 650 17,000 Not broken	450 680 17,100 73	420 630 15,000 Not broken

Table 2 (2)

Examples	9	10	11	12	13	14	15
(a) Polyamide Type Relative viscosity Compounding (Weight %)	N-6I 2.10 65	N-MXD6 2.50 70	N-PACH12 2.30 60	N-TMDT 2.60 70	N-12T 2.40 75	N-6I/PACH12 1.15 60	N-6 2.80 -80
(b) Polyolefin Type Melt index (g/10 min) Compounding (Weight %)	E/PP/DCPD 2.5 35	+	E/PP/ND 5 40	+	E/PP/EN 0.8 25	+	+
(c) Unsaturated imide or amide compound Addition (Parts by weight/ 100 Parts by weight)	N-(p-methylphenyl) maleimide 0.3	+	Itaconimide 0.5	+	N-(Carboxyphenyl) maleimide +	+	+
(d) Unsaturated carboxylic acid or its anhydride Addition (Parts by weight/ 100 Parts by weight)	Itaconic anhydride 0.15	+	Ethyl hydrogen maleate 0.2	+	Methylmaleic acid 0.25	+	+
(e) Organic peroxide Addition (Parts by weight/ 100 Parts by weight)	Butylcumyl peroxide 0.08	+	+	+	+	Dimethyl (butylperoxy) hexane 0.06	+
Discharge from extruder Polyolefin cross-linking	Good Yes	+	+	+	+	+	+
Injection molding temperature (°C)	250	250	270	210	250	270	230
Injection molding pressure (kg/cm <sup>2</sup> )	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Injection molding spiral flow length (mm)	70	110	85	100	90	100	92
Tensile strength (kg/cm <sup>2</sup> )	450	520	530	550	540	520	550
Flexural strength (kg/cm <sup>2</sup> )	650	700	720	760	750	710	760
Flexural modulus (kg/cm <sup>2</sup> )	17,000	18,400	18,600	19,200	19,500	15,600	19,000
Izod impact strength (kg·cm/cm notch)	43	40	33	30	41	55	83

Table 2 (3)

Examples	16	17	18	19	20	21	22
(a) Polyamide I) Type Relative viscosity Compounding (Weight %)	N-6 2.90 80	N-610 2.50 70	N-612 2.50 60	N-12 2.10 80	N-6/66:85/15 3.40 70	N-6/66:10/90 3.10 75	N-6/12:80/20 2.70 80
(b) Polyolefin II) Type Melt index (g/10 min) Compounding (Weight %)	E/PP 7 20	PP 13 30	PM 25 40	PE 20 20	E/BT 5 30	+	+
(c) Unsaturated imide or amide compound Addition (Parts by weight/ 100 Parts by weight)	Methacrylamide 0.3	+	+	+	N-ethylacrylamide 0.25	+	N-butylacrylamide 0.4
(d) Unsaturated carboxylic acid or its anhydride Addition (Parts by weight/ 100 Parts by weight)	Maleic anhydride 0.3	+	+	+	Maleic acid 0.2	+	Methacrylic acid 0.2
(e) Organic peroxide Addition (Parts by weight/ 100 Parts by weight)	Cumene hydroperoxide 0.07	+	+	+	+	Butylperoxy benzoate 0.05	+
Discharge from extruder Polyolefin cross-linking	Good Yes	+	+	+	+	+	+
Injection molding temperature (°C)	280	250	270	230	250	270	230
Injection molding pressure (kg/cm <sup>2</sup> )	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Injection molding spiral flow length (mm)	100	110	85	100	80	105	90
Tensile strength (kg/cm <sup>2</sup> )	550	650	660	440	420	450	420
Flexural strength (kg/cm <sup>2</sup> )	780	810	830	650	650	670	630
Flexural modulus (kg/cm <sup>2</sup> )	18,500	23,200	24,000	14,000	17,000	17,100	15,000
Izod impact strength (kg·cm/cm notch)	52	16	20	85	Not broken	70	Not broken

Table 2 (4)

Examples	23	24	25	26	27	28	29
(a) Polyamide <sup>1)</sup> Type Relative viscosity Compounding (Weight %)	N-6I 2.10 65	N-MXD6 2.30 70	N-PACM12 2.30 60	N-THUT 2.60 70	N-12T 2.40 75	N-6I/PACM12 50/50 1.85 60	M-6 2.80 80
(b) Polyolefin <sup>1)</sup> Type Melt index (g/10 min) Compounding (Weight %)	E/PP/DCPD 2.5 35	+	E/PP/ND 5 40	+	E/PP/EN 0.8 25	+	+
(c) Unsaturated imide or amide compound Addition (Parts by weight/ 100 Parts by weight)	N-phenylacrylamide 0.3	+	N,N-dimethyl- acrylamide 0.5	+	N-hydroxymethyl- acrylamide +	+	+
(d) Unsaturated carboxylic acid or its anhydride Addition (Parts by weight/ 100 Parts by weight)	Itaconic anhydride 0.15	+	Itaconic hydrogen 0.2	+	Methylmaleic acid 0.25	+	+
(e) Organic peroxide Addition (Parts by weight/ 100 Parts by weight)	Butylcumyl peroxida 0.08	+	+	+	+	Dimethyl (butylperoxy) hexane 0.06	+
Discharge from extruder Polyolefin cross-linking	Good Yes	+	+	+	+	+	+
Injection molding temperature (°C)	250	270	300	300	300	300	250
Injection molding pressure (kg/cm <sup>2</sup> )	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Injection molding spiral flow length (mm)	65	80	72	77	80	75	120
Tensile strength (kg/cm <sup>2</sup> )	440	520	530	550	540	520	550
Flexural strength (kg/cm <sup>2</sup> )	650	700	720	760	760	710	760
Flexural modulus (kg/cm <sup>2</sup> )	17,000	10,400	18,600	19,700	19,500	14,500	19,000
Izod impact strength (kg·cm/cm notch)	41	36	30	27	42	52	80

## i) Polyamide

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N-6: Polycaproamide; N-66: Polyhexamethyleneadipamide; N-610: Polyhexamethylenesebacamide; N-612: Polyhexamethylenedodecamide; N-12: Polydodecanamide; N-6/66 (85/15): Poly-(caproamide/hexamethyleneadipamide) copolymer (weight %); N-6/66 (10/90): Same as above; N-6/12 (80/20): Poly(caproamide/dodecanamide) copolymer (weight %); N-6I: Polyhexamethyleneisophthalamide; 10 N-MXD6: Polymetaxyleneadipamide; N-PACM12: Polybis(4-aminocyclohexyl)methanedodecamide; N-TMDT: Polytrimethylhexamethyleneterephthalamide; N-12T: Polydodecamethyleneterephthalamide; N-6I/PACMT (50/50): Poly(hexamethyleneisophthalamide/bis(4-aminocyclohexyl) methaneterephthalamide) copolymer (weight %).

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## ii) Polyolefin

E/PP: Poly(ethylene/propylene) copolymer (80/20 molar %); PP: Polypropylene; PMP: Poly(4-methylpentene-1); PE: Polyethylene; E/BT: Poly(ethylene/butene-1) copolymer (85/15 molar %); 20 E/PP/DCPD: Poly(ethylene/propylene/cyclopentadiene) copolymer (70/20/10 molar %); E/PP/ND: Poly(ethylene/propylene/norbornadiene) copolymer (65/25/10 molar %); E/PP/EN: Poly(ethylene/propylene/5-ethylidenenorbornene) copolymer (70/25/5 molar %).

25 Example 30

Nylon 6 of a relative viscosity of 2.80 was prepared by melt polymerization of  $\epsilon$ -caprolactam. To an ethylene/propylene copolymer consisting of 80 molar percent of ethylene and 20 molar percent of propylene, N-phenylmaleimide and maleic anhydride were added together with a small amount of di-  
30 butylperoxide, and by compounding the mixture at 200°C with an extruder used, a modified polyolefin of a melt index of 1 g/10 min having 0.3 molar percent of N-phenylmaleimide and 0.05 molar percent of maleic anhydride graft introduced was prepared.

Weighing 70% by weight of nylon 6 and 30% by weight of the copolymer of poly(ethylene/propylene)-g-N-phenyl maleimide and maleic anhydride, they were premixed then successively melt compounded at  
35 250°C with a 60 mm $\phi$  extruder used, and the discharge stability was examined. The gut discharged from the extruder was of very good spinnability and was scarcely cut during long hours of continuous run.

The composition obtained here was vacuum dried then injection molded into a test specimen for measurement of the mechanical properties. With the results shown in Table 3, it was found to be a material having a high practical value.

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References 6 to 9

Except the amounts of N-phenylmaleimide and maleic anhydride in Example 30 were changed as shown  
45 in Table 3, evaluation of the mechanical properties of the extruder compounded and injection molded test specimens was carried out. It was found that remarkable decrease in the stability of melt gut, melt flowability, or mechanical properties occurred when the modification of polyolefin was carried out in the ranges deviated from specification of the invention.

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Table 3

	Example 10	Reference 6	Reference 7	Reference 8	Reference 9
(A) Polyamide (Relative viscosity)	N-6 (2.80)	+	+	+	+
(B) Modified polyolefin (Functional group) (Molar %) (Melt index) (g/10 min)	EPR-g-NPHI/MLA (0.3/0.05) (1.0)	+	+	+	+
Compounding (A)/(B) (Weight %)	70/30	(0.3/0) (+)	(0/0.05) (+)	(5/0.05) (+)	(0.3/3) (+)
Discharge from extruder	Good	+	+	+	+
Injection molding flow (Spiral flow length) (mm)	100	Surging occurring frequently; Poor take-off of dis- charged gut	Gut cutting frequently	Greatly colored	Viscosity increasing abnormally
Tensile strength (kg/cm <sup>2</sup> )	480	120	110	90	45
Flexural strength (kg/cm <sup>2</sup> )	690	490	480	450	450
Flexural modulus (kg/cm <sup>2</sup> )	17,200	690	690	640	650
Izod impact strength (kg·cm/cm notch)	90	17,100	17,200	16,900	17,000
		40	40	90	90

(A) N-6; Nylon 6; (B) EPR-g-NPHI/MLA; Poly(ethylene/propylene)-g-N-phenylmaleimide and maleic anhydride copolymer;

Injection molding flow: Temperature, 250°C; Injection pressure, 1,000 kg/cm<sup>2</sup>; Test specimen thickness, 1.0 mm

Mechanical properties: 23°C, dry



Examples 31 to 66

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Changing the types and quantities of the polyamide and polyolefin and operating similarly to Example 30, the discharge stability of the gut from the extruder, injection moldability of the compositions and physical properties of the molded test specimens were evaluated, with the results shown in Table 4. It was found that in any of the cases shown in Table 4, there would be provided a material showing distinguished

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Table 4 (1)

Examples	31	32	33	34	35	36	37
(A) Polyamide <sup>a)</sup> Type Relative viscosity Compounding (Weight %)	N-66 2.90 75	N-610 2.50 80	N-612 2.50 60	N-12 2.30 80	N-6/66:105/15 3.40 70	N-6/66:10/90 3.10 70	N-6/12:80/20 2.70 80
(B) Modified polyolefin <sup>b)</sup> Type Melt index (g/10 min) Compounding (Weight %)	(A) 1.0 25	(A) 1.0 20	(B) 5.0 40	(B) 5.0 20	(C) 0.5 30	(C) 0.5 30	(C) 0.5 20
Discharge from extruder	Good	+	+	+	+	+	+
Injection molding Temperature (°C) Injection pressure (kg/cm <sup>2</sup> ) Spiral flow length (mm)	280 1,000 95	250 1,000 110	250 1,000 80	230 1,000 100	250 1,000 90	270 1,000 105	230 1,000 100
Tensile strength (kg/cm <sup>2</sup> )	510	450	430	430	430	440	420
Flexural strength (kg/cm <sup>2</sup> )	720	640	620	640	650	670	620
Flexural modulus (kg/cm <sup>2</sup> )	18,000	17,000	15,200	15,300	16,500	16,800	15,000
Izod impact strength (kg·cm/cm notch)	80	85	Not broken	95	90	73	Not broken

Table 4 (2)

Examples	38	39	40	41	42	43	44
(A) Polyamide <sup>a)</sup> Type Relative viscosity Compounding (Weight %)	N-6I 2.10 50	N-HXD6 2.50 70	N-PACMI2 2.30 75	N-TMDT 2.60 70	N-12T 2.40 70	N-6I/PACMI2:50/50 1.85 70	N-6 2.80 70
(B) Modified polyolefin <sup>b)</sup> Type Melt index (g/10 min) Compounding (Weight %)	[D] 0.6 50	[D] 0.6 30	[D] 0.6 25	[E] 8.4 30	[E] 8.4 30	[E] 8.4 30	[F] 20 30
Discharge from extruder	Good	+	+	+	+	+	+
Injection molding Temperature (°C) Injection pressure (kg/cm <sup>2</sup> ) Spiral flow length (mm)	250 1,000 67	270 1,000 88	300 1,000 97	300 1,000 74	300 1,000 80	300 1,000 71	250 1,000 150
Tensile strength (kg/cm <sup>2</sup> )	450	520	530	550	540	580	650
Flexural strength (kg/cm <sup>2</sup> )	630	700	720	760	740	750	800
Flexural modulus (kg/cm <sup>2</sup> )	17,100	18,500	18,800	19,800	17,800	18,800	23,000
Izod impact strength (kg·cm/cm notch)	68	44	52	39	50	45	15

Table 4 (3)

Examples	45	46	47	48
(A) Polyamide <sup>a)</sup> Type Relative viscosity Compounding (Weight %)	N-6 2.80 75	N-66 2.50 50	N-66 3.00 70	N-66 3.00 70
(B) Modified polyolefin <sup>b)</sup> Type Melt index (g/10 min) Compounding (Weight %)	(G) 10 25	(H) 15 50	(I) 5.0 30	(I) 1.0 30
Discharge from extruder	Good	+	+	+
Injection molding Temperature (°C) Injection pressure (kg/cm <sup>2</sup> ) Spiral flow length (mm)	250 1,000 110	280 1,000 120	275 1,000 90	275 1,000 82
Tensile strength (kg/cm <sup>2</sup> )	580	700	520	500
Flexural strength (kg/cm <sup>2</sup> )	700	950	680	650
Flexural modulus (kg/cm <sup>2</sup> )	19,500	25,500	16,800	16,500
Izod impact strength (kg·cm/cm notch)	80	15	90	80

Table 4 (4)

Examples	49	50	51	52	53	54	55
(A) Polyamide <sup>a)</sup> Type Relative viscosity Compounding (Weight %)	N-66 2.90 75	N-610 2.50 80	N-612 2.50 60	N-12 2.30 80	N-6/66:85/15 3.40 70	N-6/66:10/90 3.10 70	N-6/12:80/20 2.70 80
(B) Modified polyolefin <sup>b)</sup> Type Melt index (g/10 min) Compounding (Weight %)	(A) 1.0 25	(A) 1.0 20	(B) 5.0 40	(B) 5.0 20	(C) 0.5 30	(C) 0.5 30	(C) 0.5 20
Discharge from extruder	Good	+	+	+	+	+	+
Injection molding Temperature (°C) Injection pressure (kg/cm <sup>2</sup> ) Spiral flow length (mm)	280 1,000 90	250 1,000 100	250 1,000 70	230 1,000 90	250 1,000 85	270 1,000 100	230 1,000 90
Tensile strength (kg/cm <sup>2</sup> )	540	450	480	430	430	440	420
Flexural strength (kg/cm <sup>2</sup> )	750	640	650	640	650	680	620
Flexural modulus (kg/cm <sup>2</sup> )	18,000	17,000	15,200	15,300	16,700	16,800	15,200
Izod impact strength (kg·cm/cm notch)	80	80	Not broken	95	90	78	Not broken

Table 4 (5)

Examples	56	57	58	59	60	61	62
(A) Polyamide <sup>a)</sup> Type Relative viscosity Compounding (Weight %)	N-6I 2.10 50	N-PXD6 2.50 70	N-PACH12 2.30 75	N-THDT 2.60 70	N-12T 2.40 70	N-6I/PACMT.50/50 1.85 70	N-6 2.80 70
(B) Modified polyolefin <sup>b)</sup> Type Melt index (g/10 min) Compounding (Weight %)	[D] 0.6 50	[D] 0.6 30	[D] 0.6 25	[R] 8.4 30	[R] 8.4 30	[E] 8.4 30	[F] 20 30
Discharge from extruder	Good	+	+	+	+	+	+
Injection molding Temperature (°C)	250	270	300	300	300	300	250
Injection pressure (kg/cm <sup>2</sup> )	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Spiral flow length (mm)	60	85	90	70	75	70	140
Tensile strength (kg/cm <sup>2</sup> )	450	520	580	550	540	580	660
Flexural strength (kg/cm <sup>2</sup> )	630	730	720	760	760	760	800
Flexural modulus (kg/cm <sup>2</sup> )	17,200	18,500	18,800	19,600	17,800	18,800	23,000
Izod impact strength (kg·cm/cm notch)	70	45	52	39	50	50	15

Table 4 (6)

Examples	63	64	65	66
(A) Polyamide <sup>a)</sup>				
Type	N-6	N-66	N-66	N-66
Relative viscosity	2.80	2.50	3.00	3.00
Compounding (Weight %)	75	50	70	70
(B) Modified polyolefin <sup>b)</sup>				
Type	[G]	[H]	[I]	[I]
Melt index (g/10 min)	10	15	5.0	1.0
Compounding (Weight %)	25	50	30	30
Discharge from extruder	Good	+	+	+
Injection molding				
Temperature (°C)	250	280	275	275
Injection pressure (kg/cm <sup>2</sup> )	1,000	1,000	1,000	1,000
Spiral flow length (mm)	100	110	85	80
Tensile strength (kg/cm <sup>2</sup> )	580	700	520	520
Flexural strength (kg/cm <sup>2</sup> )	700	960	690	650
Flexural modulus (kg/cm <sup>2</sup> )	19,600	25,500	16,800	16,500
Isod impact strength (kg·cm/cm notch)	82	16	90	80

## a) Polyamide

N-6: Polycaproamide; N-66: Polyhexamethylenedipamide; N-610: Polyhexamethylenesbacamide; N-612: Polyhexamethylenedodecamide; N-12: Polydodecanamide; N-6/66 (85/15): Poly(caproamide/hexamethylenedipamide) copolymer (% by weight); N-6/66 (10/90): Same as above; N-6/12 (80/20): Poly(caproamide/dodecanamide) copolymer (% by weight); N-6I: Polyhexamethyleneisophthalamide; N-MXD6: Polymethaxyleneadipamide; N-PACM12: Polybis(4-aminocyclohexyl)methanedodecamide; N-TMDT: Polytrimethylhexamethylenephthalamide; N-12T: Polydodecamethyleneterephthalamide; N-6I/PACMT (50/50): Poly(hexamethyleneisophthalamide/bis(4-aminocyclohexyl)methaneterephthalamide) copolymer (% by weight).

## b) Modified polyolefin

[A]: Poly(ethylene/propylene): 80/20 (molar percent) copolymer having 0.3 molar percent of N-phenylmaleimide and 0.05 molar percent of maleic anhydride grafted.

[B]: Poly(ethylene/propylene): 80/20 (molar percent) copolymer having 0.5 molar percent of maleimide and 0.1 molar percent of fumaric acid grafted.

[C]: Poly(ethylene/butene-1): 85/15 (molar percent) copolymer having 0.5 molar percent of N-(p-methylphenyl)maleimide and 0.04 molar percent of itaconic anhydride grafted.

[D]: Poly(ethylene/propylene/dicyclopentadiene): 70/20/10 (molar percent) copolymer having 1 molar percent of N-phenylmaleimide and 0.1 molar percent of maleic anhydride grafted.

5 [E]: Poly(ethylene/propylene/5-ethylidenenorbornene): 70/25/5 (molar percent) copolymer having 0.1 molar percent of N-(carboxyphenyl)maleimide grafted.

[F]: Polypropylene having 0.5 molar percent of N-phenylmaleimide and 0.05 molar percent of maleic anhydride grafted.

10 [G]: Polyethylene having 0.5 molar percent of N-phenylmaleimide and 0.05 molar percent of maleic anhydride grafted.

[H]: Poly(4-methylpentene-1) having 0.5 molar percent of N-phenylmaleimide and 0.05 molar percent of maleic anhydride grafted.

[I]: Poly(ethylene/maleimide/maleic anhydride): 96/3/1 (molar percent) copolymer.

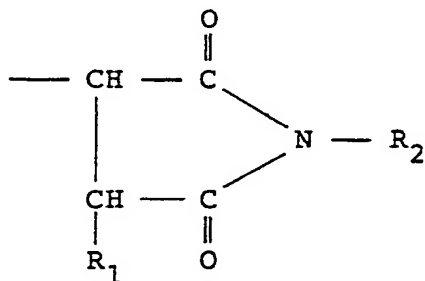
15 [J]: Poly(ethylene/propylene/butyl acrylate/maleic anhydride): 80/10/9/1 (molar percent) copolymer.

### Claims

1. A resin composition comprising (A) 50 - 95 percent by weight of a polyamide and (B) 5 - 50 percent  
20 by weight of a modified polyolefin containing in the side chain 0.005 - 5 molar percent of functional groups expressed by the formulas (I) and/or (II) and 0.005 - 5 molar percent of functional groups expressed by the formulas (III) and/or (IV)

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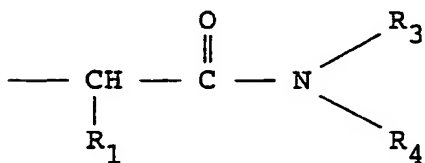
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(I)

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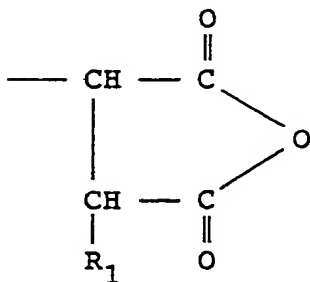
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(II)

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(III)

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where R<sub>1</sub> represents a hydrogen atom or methyl group; R<sub>2</sub>, R<sub>3</sub> and R<sub>4</sub> represent respectively a hydrogen atom or an aliphatic, alicyclic or aromatic residual group having 1 - 30 carbon atoms; and M represents a hydrogen atom or a metal ion of a valence of 1 - 3.

2. A resin composition described in Claim 1 wherein the modified polyolefin is partially cross-linked.
3. A resin composition in Claim 1 which is comprised of (A) 55 - 93 percent by weight of an polyamide and (B) 7 - 45 percent by weight of a modified polyolefin.
4. A resin composition in Claim 1 which is comprised of (A) 60 - 90 percent by weight of a polyamide and (B) 10 - 40 percent by weight of a modified polyolefin.
5. A resin composition in Claim 1 wherein the modified polyolefin (B) contains 0.01 - 4.5 molar percent of the functional groups expressed by the formulas (I) and/or (II) and 0.008 - 4 molar percent of the functional groups expressed by the formulas (III) and/or (IV).
6. A resin composition in Claim 1 wherein the modified polyolefin (B) contains 0.02 - 4 molar percent of the functional groups expressed by the formulas (I) and/or (II) and 0.01 - 3 molar percent of the functional groups expressed by the formulas (III) and/or (IV).
7. A resin composition in Claim 1 wherein R<sub>2</sub> in formula (I) is a functional group chosen from alkyl having 1 - 10 carbon atoms, phenyl, cyclohexyl and benzyl groups.
8. A resin composition in Claim 1 wherein R<sub>3</sub> and R<sub>4</sub> in formula (II) are respectively a hydrogen atom or a functional group chosen from alkyl groups having 1 - 10 carbon atoms.
9. A resin composition in Claim 1 wherein the modified polyolefin (B) is that chosen from polyethylene, polypropylene, polybutene, poly(4-methylpentene-1), ethylene/propylene copolymer, ethylene/butene-1 copolymer, ethylene/propylene/1,4-hexadiene copolymer, ethylene/propylene/5-ethylidenenorbornene copolymer, ethylene/propylene/5-ethyl-2,5-norbornadiene copolymer and ethylene/propylene/dicyclopentadiene copolymer having said functional groups.
10. A resin composition in Claim 1 wherein the polyamide (A) is that chosen from polycaproamide, polyhexamethylenedipamide, polyhexamethylenesebacamide, polyhexamethylenedodecamide, polyundecanamide, polydodecanamide, polyhexamethyleneterephthalamide, polyhexamethyleneterephthalamide, polytrimethylhexamethyleneterephthalamide, polybis(4-aminocyclohexyl)methanododecamide, polymetaxyleneadipamide, polyundecamethyleneterephthalamide, polydodecamethyleneterephthalamide and their copolymers and mixtures.
11. A method of manufacturing resin composition comprising polyamide containing partially cross-linked modified polyolefin comprising melt compounding, a mixture of 100 parts by weight of a mixture of (a) 50 - 95 percent by weight of a polyamide and (b) 5 - 50 percent by weight of a polyolefin, (c) 0.02 - 5 parts by weight of an  $\alpha,\beta$ -unsaturated imide compound and/or an  $\alpha,\beta$ -unsaturated amide compound, (d) 0.01 - 3 parts by weight of an  $\alpha,\beta$ -unsaturated carboxylic acid compound and/or an  $\alpha,\beta$ -unsaturated carboxylic acid anhydride and (e) 0.001 - 0.8 part by weight of an organic peroxide.
12. A method of manufacturing resin composition in Claim 11 wherein (a) 55 - 93 percent by weight of a polyamide and (b) 7 - 45 percent by weight of a polyolefin are used.
13. A method of manufacturing resin composition in Claim 11 wherein (a) 60 - 90 percent by weight of a polyamide and (b) 10 - 40 percent by weight of a polyolefin are used.
14. A method of manufacturing resin composition in Claim 11 wherein (c)  $\alpha,\beta$ -unsaturated imide compound and/or  $\alpha,\beta$ -unsaturated amide compound are used in 0.05 - 3 parts by weight, (d)  $\alpha,\beta$ -unsaturated carboxylic acid compound and/or  $\alpha,\beta$ -unsaturated carboxylic acid anhydride are used in 0.02 - 1 part by weight and (e) organic peroxide is used in 0.004 - 0.5 part by weight.
15. A method of manufacturing resin composition in Claim 11 wherein (c)  $\alpha,\beta$ -unsaturated imide compound and/or  $\alpha,\beta$ -unsaturated amide compound are used in 0.07 - 1 part by weight, (d)  $\alpha,\beta$ -unsaturated carboxylic acid compound and/or  $\alpha,\beta$ -unsaturated carboxylic acid anhydride are used in 0.05 - 0.8 part by weight and (e) organic peroxide is used in 0.008 - 0.2 part by weight.
16. A method of manufacturing resin composition in Claim 11 wherein (a) polyamide is chosen from polycaproamide, polyhexamethylenedipamide, polyhexamethylenesebacamide, polyhexamethylenedodecamide, polyundecanamide, polydodecanamide, polyhexamethyleneterephthalamide, poly-

hexamethyleneterephthalamide, polybis(4-aminocyclohexyl)methanedodecamide, polymetaxyleneadipamide, polyundecamethyleneterephthalamide, polydodecamethyleneterephthalamide and their copolymers and mixtures.

17. A method of manufacturing resin composition in Claim 11 wherein (b) polyolefin is chosen from polyethylene, polypropylene, polybutene, poly(4-methylpentene-1), ethylene/propylene copolymer, ethylene/butene-1 copolymer, ethylene/propylene/1,4-hexadiene copolymer, ethylene/propylene/5-ethylidenenorbornene copolymer, ethylene/propylene/5-ethyl-2,5-norbornadiene copolymer and ethylene/propylene/dicyclopentadiene copolymer.

18. A method of manufacturing resin composition in Claim 11 wherein (c)  $\alpha,\beta$ -unsaturated imide compound and/or  $\alpha,\beta$ -unsaturated amide compound are at least one kind of compound chosen from maleimide, N-methylmaleimide, N-ethylmaleimide, N-propylmaleimide, N-butylmaleimide, N-octylmaleimide, N-phenylmaleimide, N-(o-methylphenyl) maleimide, N-(m-methylphenyl)maleimide, N-(p-methylphenyl) maleimide, N-(methoxyphenyl)maleimide, N-(chlorophenyl) maleimide, N-(carboxyphenyl)maleimide, N-benzylmaleimide, N-naphthylmaleimide, N-cyclohexylmaleimide, itaconimide, N-methylitaconimide, N-phenylitaconimide, acrylamide, N-methylacrylamide, N-ethylacrylamide, N-propylacrylamide, N-butylacrylamide, N-octylacrylamide, N-stearylacrylamide, N-methylolacrylamide, N-hydroxymethylacrylamide, N-cyanoethylacrylamide, N-phenylacrylamide, N-tolylacrylamide, N,N-dimethylacrylamide, N,N-diethylacrylamide, diacetoneacrylamide, methacrylamide, N-methylmethacrylamide, N-ethylmethacrylamide, N-propylmethacrylamide, N-butylmethacrylamide, N-stearylmethacrylamide, N-methylolmethacrylamide, N-hydroxymethylmethacrylamide, N-cyanoethylmethacrylamide, N-phenylmethacrylamide, N-benzylmethacrylamide, N,N-dimethylmethacrylamide and N,N-diethylmethacrylamide.

19. A method of manufacturing resin composition in Claim 11 wherein (c)  $\alpha,\beta$ -unsaturated imide compound and/or  $\alpha,\beta$ -unsaturated amide compound are at least one kind of compound chosen from N-cyclohexylmaleimide, N-benzylmaleimide, N-phenylmaleimide, N-(carboxyphenyl)maleimide, acrylamide and methacrylamide.

20. A method of manufacturing resin composition in Claim 11 wherein (d)  $\alpha,\beta$ -unsaturated carboxylic acid compound and/or  $\alpha,\beta$ -unsaturated carboxylic acid anhydride are at least one kind of compound chosen from acrylic acid, methacrylic acid, maleic acid, fumaric acid, itaconic acid, crotonic acid, methylmaleic acid, methylfumaric acid, mesaconic acid, citraconic acid, glutaconic acid, methyl hydrogen maleate, ethyl hydrogen maleate, butyl hydrogen maleate, methyl hydrogen itaconate, ethyl hydrogen itaconate, maleic anhydride, itaconic anhydride and citraconic anhydride.

21. A method of manufacturing resin composition in Claim 11 wherein (d)  $\alpha,\beta$ -unsaturated carboxylic acid and/or  $\alpha,\beta$ -unsaturated carboxylic acid anhydride are at least one kind of compound chosen from acrylic acid, methacrylic acid, maleic acid, fumaric acid, methyl hydrogen maleate, maleic anhydride and itaconic anhydride.

22. A method of manufacturing resin composition in Claim 11 wherein (e) organic peroxide is at least one kind of peroxide chosen from cumenehydroperoxide, t-butylcumylperoxide, di-t-butylperoxide, 2,5-dimethyl-2,5-(t-butylperoxy)hexane, 2,5-dimethyl-2,5-di(t-butylperoxy)hexyne(3), 2,5-dimethylhexane-2,5-dihydroperoxide, t-butylhydroperoxide, di-isopropylbenzenehydroperoxide, p-methanehydroperoxide, 1,1-bis-t-butylperoxy-3,3,5-trimethylcyclohexane, n-butyl-4,4-bis-t-butylperoxyvalerate and t-butylperoxybenzoate.